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54 Photoelectric smoke detector.

57 A photoelectric smoke detector of the light scattering type uses for synchronizing the pulse-wise operated light source (4) and the light receiving element (6) a flip-flop circuit (R.S.-FF) which is set when scattered light is received at the same time when the light source is lit, but is reset when no light scattering is occurring at this time. An alarm signal is produced through a quick-reset integration circuit (I) only when a number of scattered light pulses are received subsequently originating from a fire. No false alarm is given by electric or light noise or cigarette smoke clouds. This smoke detector is preferably used as fire alarm.

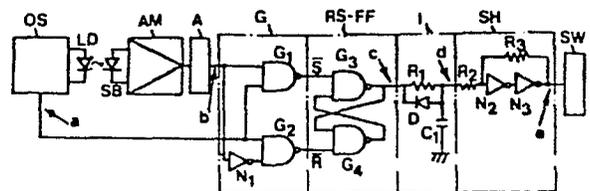


Fig.1

EP 0 011 205 A1

Smoke Detector

This invention relates to a photoelectric smoke detector comprising a light source operating at predetermined intervals and a light receiving element actuating an alarm circuit when light scattered by smoke is received
5 synchronously with the operation of the light source at said predetermined intervals.

Photoelectric smoke detectors with these characteristics may especially be used as fire alarms.

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In a detector of this type which produces a fire alarm signal by detecting light scattered by smoke particles generated by a fire, in order to reduce current consumption and non-genuine alarms, a light source is emitting
15 visible light, infrared or ultraviolet radiation periodically and a light receiving element is synchronized with the light source. A fire alarm signal is generated when the output of the light receiving element exceeds a predetermined threshold value. A circuit of this
20 kind is already known by the Japanese Patent No. 519 362 (Publication No. sho 43-51).

Though the above-mentioned detector has the merit to remarkably reduce non-genuine alarms, there is still a fair
25 possibility of producing a false alarm by single electric noise or a flash light etc. synchronized with the light source. Furthermore an alarm may be caused by clouds of cigarette smoke etc. even if no fire is existing.

30 It is an object of the invention to avoid the above-mentioned defects of prior art and to obtain a detector which does not operate on electric noise or noise light

synchronized with the light source, and which is not influenced by cigarette smoke.

The invention is characterized by the fact that the alarm
5 circuit is actuated through a flip-flop circuit which is set when the light source and the light receiving element are delivering an output signal at the same time, and which is reset when the light source is delivering an output
10 signal and at the same time the light receiving element is delivering an output signal.

An embodiment of the invention is described with reference to the accompanying drawings.

15 Fig. 1 shows a circuit diagram of a smoke detector according to this invention.

Fig. 2 shows time diagrams at various points of this circuit.

20 In the embodiment of the invention shown in Fig. 1, a light source LD, e.g. consisting of a light emission diode, is arranged in a dark chamber to which smoke may enter freely and is lit periodically with a period T and
25 a pulse width τ controlled by an oscillation circuit OS, e.g. consisting of a PUT or an equivalent circuit. A light receiving element SB, e.g. consisting of a solar battery, is so arranged in the dark chamber that in normal condition no light can reach the light receiving element
30 directly and it receives only the light scattered by smoke particles in the dark chamber. An amplifier circuit AM, e.g. consisting of an operational amplifier, amplifies the output of the light receiving element SB, and its output terminal is connected with a wave form shaping

circuit A which, as occasion demands, shapes the output of the amplifier circuit AM to a predetermined pulse. A gate circuit G is used for obtaining synchronous outputs of the light source LD or its operating circuit OS and the light receiving element SB. The input terminals of the NAND circuit G1 are connected with the output of the wave form shaping circuit A (or directly with the output of the amplifier circuit AM) and with the output of the oscillation circuit OS, respectively, and the input terminals of another NAND circuit G2 are connected with the output of the wave form shaping circuit A (or directly with the output of the amplifier circuit AM) via a NOT circuit N1 and with the output of the oscillation circuit OS, respectively.

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These NAND circuits G1 and G2 are connected with set terminal \bar{S} and reset terminal \bar{R} of a reset-set-flip-flop circuit. R.S-FF (hereinafter called "R.S-FF") which is consisting of, for instance, a pair of back-coupled NAND circuits G3 and G4. An integrating circuit I, connected with the output of the R.S-FF, comprises a diode D connected in parallel with a resistor R1 and earthed via a capacitor C1. The capacitor C1 is charged by the operation of R.S-FF, and is quickly discharged on the reset of R.S-FF via the diode D and the R.S-FF. The output of the integrating circuit I is connected with a SCHMITT circuit SH operated by a predetermined output of the integrating circuit I. The SCHMITT circuit SH may be so constructed that, for instance, a resistor R2 is connected in series with two NOT circuits N2 and N3 and the output of the NOT circuit N3 is connected with the input of the NOT circuit N2 via a resistor R3. Furthermore, the SCHMITT circuit SH is connected with a switching circuit SW which is, as occasion demands, consisting of a SRC or equivalent components.

The operation of the above-mentioned detector is described with reference to figure 2 showing time diagrams of the voltage wave-form at various points a - e in Fig. 1, at the outputs of the amplifier circuit AM and the gate circuit G, and at the inputs \bar{R} and \bar{S} of the R.S-FF.

In normal condition, during the period of time T_1 , because no smoke exists in the dark chamber of the detector, even if the light source LD is lit periodically by the oscillation circuit OS with a period T and a pulse width τ , the light receiving element SB receives no light scattered by smoke particles, and accordingly the amplifier circuit AM or the wave form shaping circuit A produces no output. Consequently, even if the one input terminal of the NAND circuit G1 of the gate circuit G receives high level input (hereinafter called simply "H-level") from the oscillation circuit OS, the other input terminal receives low level input (hereinafter called simply "L-level"), and accordingly the output of the NAND circuit G1 and the set input S of the R.S-FF maintain the H-level. On the contrary, because the NAND circuit G2 is provided with a NOT circuit N1 at its one input terminal, its output and the reset input R of the R.S-FF is changed into the L-level synchronously with the oscillation circuit OS, and therefore the R.S-FF continuously resets the following integrating circuit I. Accordingly the integrating circuit I produces no output and the switching circuit SW does not operate.

Even if the output of the amplifier circuit AM or the wave form shaping circuit A is changed into H-level during a short period of time t_1 , for instance by cigarette smoke clouds or noise light occurring synchronously with the output of the oscillation circuit OS, and thereby the output

of the NAND circuit G1 is changed into L-level, and consequently R.S-FF is set and its output is changed into H-level, thus, the capacitor C1 of the integrating circuit I is charged via the resistor R1 only a little. But when
5 the light source LD is lit in the next period, the NAND circuit G1 has returned to the H-level and the NAND circuit G2 has come to L-level, so that the R.S-FF is reset anew. Consequently, the electric charge of the capacitor C1 is rapidly discharged via the diode D and
10 the R.S-FF, and thus, the SCHMITT circuit SH and the switching circuit SW are kept in non-operating condition so that no alarm is produced.

But, in the case of a real fire condition during the
15 following period of time T2, whereby scattered light is received continuously during the operation periods of the light source, the NAND circuit G2 maintains H-level, while the NAND circuit G1 is changed into L-level synchronously with the oscillation circuit OS.

20 Therefore the R.S-FF is continuously kept on set, and accordingly the charging of the capacitor C1 is continued. When the charge voltage at point d has reached the operating level g, the SCHMITT circuit SH and the switching
25 circuit SW are operated and a fire alarm signal is produced.

In this embodiment of the invention the integrating circuit is controlled by a flip-flop circuit, and by properly
30 determining the operating cycle of the light source and the threshold value of the SCHMITT circuit and the switching circuit, a smoke detector which does not operate on cigarette smoke, electric noise or noise light synchronized with the light source is obtainable. If the cir-

uits or the above-mentioned embodiment comprise CMOS components (complementary MOS), a photoelectric smoke detector with small current consumption is obtained.

Claims:

1. Photoelectric smoke detector comprising a light source (LD) operating at predetermined intervals and a light receiving element (SB) actuating an alarm circuit (SH, SW) when light scattered by smoke is received synchronously with the operation of the light source (LD) at said predetermined intervals, characterized by the fact that the alarm circuit (SH) is operated through a flip-flop circuit (R.S-FF) which is set when the light source (LD) and the light receiving element (SB) are delivering an output signal and which is reset when the light source (LD) is delivering an output signal and at the same time the light receiving element (SB) is delivering no output signal.
2. Detector according to claim 1, characterized by the fact that the flip-flop circuit (R.S-FF) comprises a pair of back-coupled NAND circuits (G3, G4).
3. Detector according to claim 2, characterized by the fact, that the free input (\bar{S}) of one of the back-coupled NAND circuits (G3) forming the set input of the flip-flop circuit is connected to a first gate circuit (G1) delivering a set signal when its inputs receive synchronously a signal from the light receiving element (SB) and from the light source (LD) or its operating circuit (OS), and that the free input (\bar{R}) of the other back-coupled NAND circuit (G4) forming the reset input of the flip-flop circuit is connected to a further gate circuit (G2) delivering a reset signal when its inputs receive synchronously a signal from the light source or its operating circuit (OS), but no signal from the light receiving element.

4. Detector according to claim 3, characterized by the fact, that the gate circuits (G1, G2) comprise NAND gates.
- 5 5. Detector according to claim 4, characterized by the fact, that a NOT circuit (N1) is provided at one input of at least one of the NAND gates (G1, G2).
6. Detector according to one of the claims 1 to 5,
10 characterized by the fact, that the output of the flip-flop circuit (R.S-FF) is connected to an integration circuit (I) which is charged by the output of the flip-flop circuit (R.S-FF) and discharged when the flip-flop circuit is reset, and which is actuating the alarm
15 circuit.
7. Detector according to claim 7, characterized by the fact that the integration circuit (I) comprises a capacitor (C1) and a charging resistor (R1) to which a diode (D) for
20 discharging the capacitor (C1) is connected in parallel.
8. Detector according to one of claims 6 or 7, characterized by the fact, that the alarm circuit comprises a SCHMITT circuit (SH), operated by the integration
25 circuit (I).

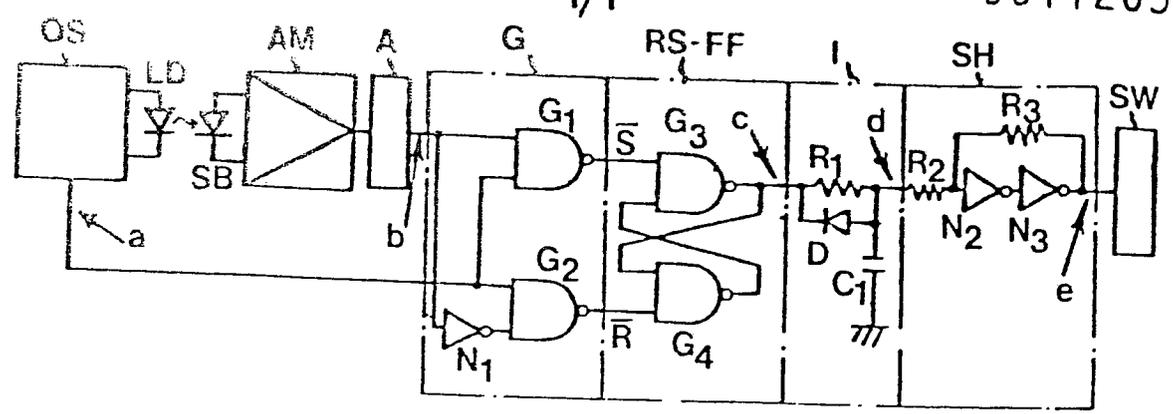


Fig.1

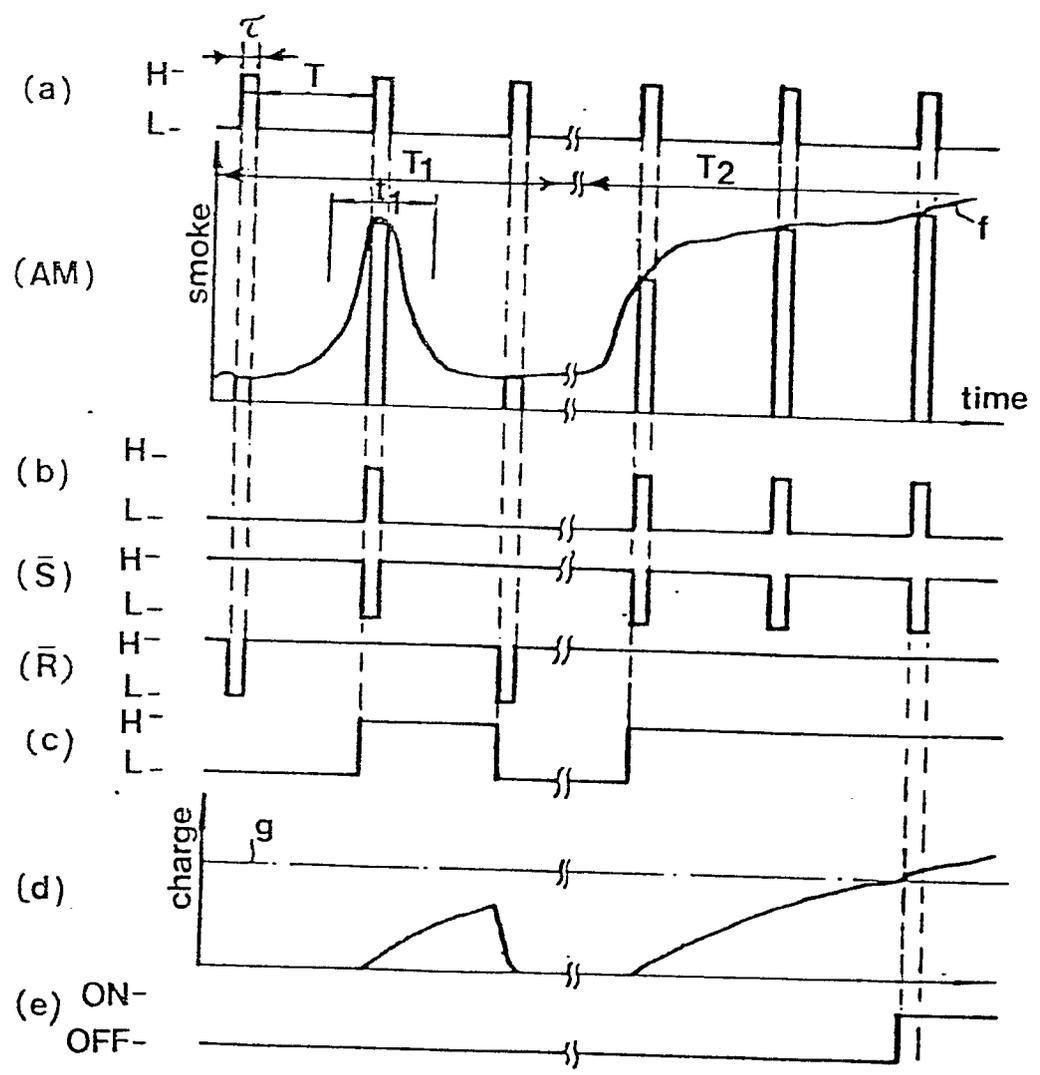


Fig.2



DOCUMENTS CONSIDERED TO BE RELEVANT		CLASSIFICATION OF THE APPLICATION (Int. Cl. 7)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
	<p>US - A - 3 946 241 (MALINOWSKI)</p> <p>* Title-page, abstract; column 1, line 55 - column 2, line 63 *</p> <p style="text-align: center;">-----</p>	1,6
		G 08 B 17/10
		TECHNICAL FIELDS SEARCHED (Int.Cl. 3)
		G 08 B 17/10
		CATEGORY OF CITED DOCUMENTS
		<p>X: particularly relevant</p> <p>A: technological background</p> <p>O: non-written disclosure</p> <p>P: intermediate document</p> <p>T: theory or principle underlying the invention</p> <p>E: conflicting application</p> <p>D: document cited in the application</p> <p>L: citation for other reasons</p>
		&: member of the same patent family, corresponding document
The present search report has been drawn up for all claims		
Place of search	Date of completion of the search	Examiner
The Hague	26-02-1980	ORNELIS